

1 Bachelor Degree Structure (4-Year International Standard)

Year	Focus	Typical Subjects
Year 1	Foundations	Mathematics (Calculus, Linear Algebra, Differential Equations), Physics (Mechanics, Thermodynamics, Electricity & Magnetism), Chemistry (General + Physical), Intro to Materials Science
Year 2	Core Materials	Atomic Structure & Crystallography, Mechanical Properties of Materials, Thermodynamics of Materials, Materials Characterization, Materials Processing
Year 3	Advanced & Applied	Metals & Alloys, Ceramics, Polymers, Composites, Corrosion & Failure Analysis, Materials Design, Experimental Labs, Computational Materials Science
Year 4	Electives + Capstone	Nano Materials, Biomaterials, Functional / Electronic Materials, Advanced Manufacturing, Computational Modeling, Capstone Design Project / Internship / Research

Notes:

- Labs and projects are essential, usually 20–30% of course time.
 - Courses may vary slightly depending on the university (focus on materials physics vs engineering).
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2 Core Topics by Year

Year 1 - Foundations

- Mathematics for engineers (calculus, linear algebra, diff. eq.)
- Physics: mechanics, thermodynamics, waves
- Chemistry: atomic structure, bonding, stoichiometry
- Introduction to Material Science (types of materials, history, applications)

Recommended Books

- *Materials Science and Engineering: An Introduction* – William D. Callister

- *Fundamentals of Materials Science and Engineering* – Smith & Hashemi
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□ **Year 2 - Material Structures & Properties**

- Atomic structure and bonding
- Crystal structures and defects
- Mechanical properties: stress, strain, elasticity, plasticity
- Thermal properties: heat capacity, thermal conductivity
- Phase diagrams & phase transformations
- Introduction to materials processing

Recommended Books

- *Physical Metallurgy Principles* – Reed-Hill
 - *Materials Science and Engineering: An Introduction* – Callister (continued)
 - *Introduction to Solid State Physics* – Charles Kittel
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□ **Year 3 - Advanced Materials & Applications**

- Metals, alloys, ceramics, polymers, composites
- Corrosion and environmental effects
- Failure analysis and fracture mechanics
- Advanced materials characterization (XRD, SEM, TEM, spectroscopy)
- Computational Materials Science (simulation, modeling)

Recommended Books

- *Mechanical Behavior of Materials* – Norman E. Dowling
 - *Introduction to Polymers* – Young & Lovell
 - *Composite Materials: Science and Applications* – Deborah D.L. Chung
 - *Elements of X-Ray Diffraction* – Cullity
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□ Year 4 - Specialization & Capstone

- Nano materials, biomaterials, electronic / functional materials
- Advanced manufacturing & additive manufacturing
- Nuclear / aerospace materials (optional electives)
- Materials design, life-cycle assessment
- Capstone project: experimental + computational + report

Recommended Books

- *Nanostructures and Nanomaterials* – Guozhong Cao
 - *Materials Modelling Using Density Functional Theory* – Giustino
 - *Corrosion Engineering* – Mars G. Fontana
 - *Failure of Materials in Mechanical Design* – Shigley
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3□ Skills You Will Build

- Understanding **structure** → **properties** → **performance**
 - Materials **characterization** using modern lab techniques
 - Mechanical, thermal, and chemical property prediction
 - Materials selection for engineering applications
 - Computational simulations (DFT, molecular dynamics)
 - Capstone/research skills and experimental problem-solving
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4□ Suggested Roadmap for Reading (Books)

1. Year 1-2:

- Callister – *Materials Science and Engineering*
- Kittel – *Solid State Physics* (intro to crystals)

2. Year 2-3:

- Reed-Hill – *Physical Metallurgy Principles*
- Dowling – *Mechanical Behavior of Materials*

- o Young & Lovell – *Introduction to Polymers*

3. Year 3-4:

- o Chung – *Composite Materials*
- o Cullity – *X-Ray Diffraction*
- o Nano materials – Cao
- o Computational / advanced topics – Giustino

1□ International Bachelor's Degree Structure in Nuclear Science

Year	Focus	Typical Subjects
Year 1	Foundations	Mathematics (Calculus, Linear Algebra, Differential Equations), Physics (Mechanics, Electricity & Magnetism, Thermodynamics, Waves), General Chemistry, Intro to Nuclear Science
Year 2	Core Nuclear Science	Classical Physics Applied to Nuclear Systems, Nuclear Physics, Radiation Physics, Quantum Mechanics (intro), Materials for Nuclear Applications, Thermodynamics & Fluid Mechanics for Nuclear Systems
Year 3	Advanced Nuclear Topics	Reactor Physics, Nuclear Engineering Fundamentals, Radiation Detection & Instrumentation, Nuclear Materials & Fuel Cycles, Health Physics & Radiation Protection, Nuclear Thermal-Hydraulics, Lab/Simulation work
Year 4	Electives & Capstone	Advanced Reactor Design, Nuclear Safety & Regulations, Nuclear Fusion / Advanced Nuclear Systems, Computational Modeling in Nuclear Engineering, Capstone Design Project / Internship / Research

Notes:

- Labs and simulation courses are emphasized internationally (Monte Carlo simulations, reactor modeling).

- Courses vary slightly depending on the focus: nuclear physics vs. nuclear engineering.
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2▯ Core Topics

▯ Nuclear & Reactor Physics

- Nuclear structure and reactions
- Radioactive decay
- Fission & fusion
- Neutron interactions and transport
- Reactor kinetics

▯ Radiation & Detection

- Types of radiation (α , β , γ , neutrons)
- Detection instruments (Geiger, scintillation, semiconductor detectors)
- Radiation dosimetry
- Health physics principles

▯ Materials & Fuel

- Nuclear fuel materials (Uranium, Plutonium)
- Radiation damage & material degradation
- Nuclear waste management
- Structural materials in reactors

▯ Thermal & Fluid Systems

- Thermodynamics applied to reactors
- Heat transfer & cooling
- Fluid mechanics in nuclear systems
- Reactor thermal hydraulics

▯ Safety & Regulations

- Reactor safety principles

- Risk assessment
- International nuclear regulations (IAEA standards)
- Emergency response

□ **Computational / Simulation**

- Monte Carlo neutron transport
 - Reactor modeling
 - Nuclear system simulations
 - Radiation transport codes (MCNP, SCALE, OpenMC)
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3 □ **Recommended Textbooks (by topic and year)**

□ **Year 1-2: Foundations**

- **“Physics for Scientists and Engineers” - Serway & Jewett**
For mechanics, waves, thermodynamics.
 - **“Modern Physics” - Tipler & Llewellyn**
For introductory nuclear & quantum concepts.
 - **“Introduction to Nuclear Science” - Kenneth S. Krane**
Beginner-friendly overview of nuclear structure, radioactivity, and fundamental nuclear physics.
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□ **Year 2-3: Core Nuclear & Reactor Physics**

- **“Nuclear Physics: Principles and Applications” - John Lilley**
Covers nuclear reactions, decay, and applications.
 - **“Introductory Nuclear Engineering” - John R. Lamarsh & Anthony J. Baratta**
Widely used in international nuclear engineering programs.
 - **“The Physics of Nuclear Reactors” - Serge Marguet**
Reactor physics fundamentals.
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□ **Year 3: Radiation & Instrumentation**

- **“Radiation Detection and Measurement” - Glenn F. Knoll**
Standard text for detectors and instrumentation.
 - **“Introduction to Health Physics” - Herman Cember & Thomas Johnson**
For radiation safety, dosimetry, shielding.
 - **“Fundamentals of Nuclear Science and Engineering” - J. Kenneth Shultis & Richard Faw**
A modern overview combining physics, engineering, and applications.
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□ **Year 3-4: Advanced & Specialized**

- **“Nuclear Reactor Physics” - Weston M. Stacey**
Advanced reactor physics concepts.
 - **“Nuclear Fuel Cycle Science and Engineering” - Ian Hore-Lacy / International Atomic Energy Agency resources**
 - **“Computational Nuclear Engineering and Radiological Physics” - T. Yamamoto / K. Shultis**
Simulation-focused applications, Monte Carlo methods.
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□ **Electives / Capstone**

- **“Fusion: The Energy of the Universe” - G. H. Miley**
For fusion reactors, plasma physics.
 - **“Nuclear Energy: Principles, Practices, and Prospects” - David Bodansky**
Broader view on nuclear energy, sustainability, policy.
 - **IAEA Manuals / NRC Reports**
For practical safety, regulations, and standards.
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4□ Skills You’ll Build in Bachelor Program

- Nuclear physics and reactor physics fundamentals
- Radiation measurement & protection
- Materials behavior under radiation

- Thermal-hydraulics for reactors
- Reactor modeling & computational simulation
- Laboratory & instrumentation experience
- Capstone project design & real-world problem solving

□ **ROADMAP: Statistics → Computer Science → Machine Learning**

□ **Stage 1: Bridge A-Level → University / ML Stats**

Goal: Turn exam-style statistics into *thinking like a data scientist*

□ **All of Statistics — Larry Wasserman**

□ *This is the PERFECT next book for you*

Why this book

- Assumes you already know basic probability
- Compact but deep
- Covers **everything ML expects from statistics**

Key topics you'll gain

- Random variables (rigorous)
- Estimation & consistency
- Maximum Likelihood Estimation (MLE)
- Bayesian inference (intro)
- Concentration inequalities
- Nonparametric statistics

□ *Mindset shift:*

From “calculate p-value” → “what does this estimator actually mean?”

□ **How to study**

- Read slowly
- Don't memorize proofs

- Focus on intuition + assumptions
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□ **Stage 2: Statistics → Machine Learning Core**

Goal: Understand why ML algorithms work

□ **An Introduction to Statistical Learning (ISLR)**

James, Witten, Hastie, Tibshirani

Why it's essential

- Direct bridge from statistics → ML
- Minimal math, maximum insight
- Used in top CS programs

What it adds

- Linear & logistic regression (ML view)
- Bias-variance tradeoff
- Cross-validation
- Regularization (Ridge, Lasso)
- Classification vs regression

□ *This book rewires your intuition.*

□ **Study tip**

- Ignore R code if you want
 - Focus on graphs & explanations
 - Re-derive ideas using math you know
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□ **Stage 3: Probability for ML (Critical Level-Up)**

Goal: Think probabilistically like ML models do

□ **Pattern Recognition and Machine Learning — Christopher Bishop**

△ This is **hard** — but gold.

Why this book

- ML = probability in disguise
- Bayesian thinking everywhere
- Used in AI research & grad school

Core ideas

- Multivariate probability
- Bayesian inference
- Graphical models
- EM algorithm
- Probabilistic interpretation of ML models

□ How to survive this book

- Don't read cover to cover
- Focus on:
 - Chapters 1-3 (probability foundations)
 - Bayesian linear regression
 - Classification probabilistic view

□ If you understand 50% of this book → you're already *advanced*.

□ Stage 4: Statistical Learning Theory (Advanced CS Level)

Goal: Understand ML *theoretically*

□ The Elements of Statistical Learning (ESL)

Hastie, Tibshirani, Friedman

Why it matters

- Mathematical depth
- Explains:
 - Overfitting formally
 - Model complexity
 - High-dimensional data

Key topics

- Bias-variance decomposition
- Kernel methods
- Decision trees & ensembles
- Regularization theory

□ How to use

- Use as a **reference**, not first read
 - Pair with ISLR chapters
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□ Stage 5: Bayesian Statistics (Optional but Powerful)

Goal: Uncertainty-aware ML & research readiness

□ Bayesian Data Analysis — Gelman et al.

Why it's special

- Real-world uncertainty
- Hierarchical models
- Modern Bayesian thinking

□ Best if you aim for:

- AI research
- Probabilistic ML
- Scientific computing

1□ Core Topics in a Bachelor's Degree in Electronic Engineering

(These are common worldwide: UK, EU, Germany, Asia)

□ Year 1 - Foundations (Survival + Brain-Wiring Year)

Math & Physics (very heavy)

- Engineering Mathematics I
 - Calculus (single & multivariable)
 - Linear algebra
 - Differential equations
- Engineering Physics
 - Electricity & magnetism
 - Waves
 - Semiconductor physics (intro)

Core EE Basics

- Circuit Theory I
 - Ohm's law, KCL, KVL
 - DC & AC circuits
- Electrical Measurements & Instruments
- Programming for Engineers
 - C / Python / MATLAB

□ Typical Books

- *Engineering Mathematics* — K.A. Stroud / Erwin Kreyszig
 - *Physics for Scientists and Engineers* — Serway & Jewett
 - *Electrical Engineering: Principles & Applications* — Allan Hambley
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□ Year 2 - Real Electronics Begins

Analog & Digital Core

- Electronic Devices
 - Diodes, BJTs, MOSFETs
- Analog Electronics
 - Amplifiers
 - Op-amps

- Digital Electronics
 - Logic gates
 - Flip-flops
 - Counters
- Signals & Systems
 - Fourier series
 - Laplace transform

Supporting Subjects

- Probability & Random Processes
- Electromagnetic Theory I

□ Typical Books

- *Electronic Devices and Circuit Theory* — Boylestad & Nashelsky
 - *Microelectronic Circuits* — Sedra & Smith
 - *Signals and Systems* — Oppenheim & Willsky
 - *Digital Design* — Morris Mano
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□ Year 3 - Specialization & Systems Thinking

Advanced Electronics

- Analog Integrated Circuits
- Digital System Design
- Microprocessors & Microcontrollers
- Control Systems
- Communication Systems (Analog + Digital)

Power & Fields

- Power Electronics
- Electromagnetic Waves

□ Typical Books

- *CMOS Analog Circuit Design* — Allen & Holberg
 - *Modern Control Engineering* — Ogata
 - *Communication Systems* — Simon Haykin
 - *Microprocessor Architecture* — Barry Brey
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□ **Year 4 - Advanced + Research + Industry**

Advanced / Electives

- VLSI Design
- Embedded Systems
- RF & Microwave Engineering
- Optical / Fiber Communications
- Digital Signal Processing (DSP)
- Renewable Energy Systems
- Robotics / IoT

Capstone Project

- Hardware + simulation + report + presentation

□ **Typical Books**

- *Digital Signal Processing* — Proakis & Manolakis
 - *RF Microelectronics* — Razavi
 - *VLSI Design* — Weste & Harris
 - *Embedded Systems* — Jonathan Valvano
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2□ How Electronic Engineering Books Are Structured

(This is important — many students don't realize this)

□ **Standard EE Book Structure**

1. **Physical principle**
→ What actually happens in nature

2. **Mathematical model**
→ Equations & laws
3. **Circuit / System model**
→ Practical representation
4. **Analysis techniques**
→ Solve, simplify, predict
5. **Design examples**
→ Choose components
6. **Real-world limitations**
→ Noise, non-idealities
7. **Problems**
 - Conceptual
 - Numerical
 - Design-based

△ If you *skip step 1*, electronics feels like magic formulas.

△ If you *skip step 6*, designs fail in real life.

3▣ **Skill Stack You Build (Quietly but Powerfully)**

By graduation, you'll be comfortable with:

- ▣ Math-heavy reasoning
- ▣ Circuit design & simulation (LTspice, Multisim)
- ▣ Systems thinking (signals → blocks → outputs)
- ▣ Programming + hardware integration
- ▣ Reading research papers & datasheets

This is why **electronics graduates can move into:**

- Aerospace & avionics
- Robotics
- Semiconductor industry
- AI hardware

- Power & energy
- Communications & networking